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CHEMICAL SAFETY - PESTICIDES

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People who become involved in activities requiring exposure to pesticides should be aware of the potential hazards involved as a result of absorption of toxic compounds. If a person is knowledgeable about such hazards and understands the importance of taking proper precautions, he can do much to insure the safety of himself and others. Although illnesses resulting from over-exposure to toxic compounds do occur among applicators and other workers, most are a result of carelessness or accident. Experience has shown that if proper precautionary measures are observed and directions on the pesticide label are followed, even the more toxic compounds can be used safely. Exposure to less toxic compounds should not be ignored.

Much of the pesticide usage in this country involves insecticides, acaricides, fungicides and herbicides. The more extensively used modern synthetic insecticide or acaricide compounds are the chlorinated hydrocarbons, organophosphorus and carbamate compounds. The acute toxicity of the organophosphorus compounds is, on the average, somewhat greater than that of the carbamates or chlorinated hydrocarbons. Because chlorinated hydrocarbons are much more stable than organic phosphorus or carbamate compounds, they can be more of a residue problem. Carbamate pesticides have been considered relatively safe to use; however, certain of the newer compounds in this group are relatively toxic to warm-blooded animals. More experience with

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their use will allow better judgment as to their hazard to applicators or other workers.

With the exception of mercury compounds, most common fungicides are less toxic than DDT. Acute poisoning by organic mercury compounds in man is rare in the United States, although such poisonings have been reported. However, in other countries there have been many cases of chronic poisoning involving both inorganic and organic mercury. Most chronic cases have been associated with repeated exposure from the manufacturing of organic mercury compounds, from their use in treating seed, or from eating treated seed.

Certain fungicides, particularly ziram, may occasionally cause local irritations or dermatitis. However, these cases are not usually very severe.

Most herbicides are less toxic than other types of pesticides. Two of the most toxic older materials commonly used as herbicides are arsenicals and dinitro-type compounds. The arsenical herbicides, although not particularly hazardous to spraymen by skin contact, do have a poor safety record. A dinitro compound (dinitrocresol) used for weed control has caused occupational illnesses and deaths in Europe (3). In contrast, tests have indicated that under the conditions of use in the Pacific Northwest area of this country the hazard associated with the application of dinitro compounds is minimal for weed control (18). This conclusion has been corroborated by use experience.

We do not often see acute illnesses as a result of exposure to the newer herbicides. Complaints are usually about skin disorders or respiratory irritation or distress. However, one of the newer

herbicides, paraquat, is of considerable interest because only a very small oral dose may produce irreversible lung fibrosis which usually leads to death (2). Response to antidotal procedures has been rare. Although many of the recorded deaths from paraquat have been due to voluntary ingestion with suicidal intent, there have been deaths following accidental ingestion of very small amounts of the liquid concentrate. In one case it was estimated that the quantity of fluid consumed could not have exceeded three-quarters of a teaspoon (8). This compound is also somewhat caustic and may cause chemical damage, especially to the eyes. This emphasizes the importance of avoiding splashing the concentrate into the mouth or eyes during measuring and mixing operations.

The other herbicide of most current toxicologic interest is 2,4,5,-T. This compound, along with its dioxin contaminant, has caused teratologic effects in experimental animals when given at sufficiently high dosage levels (5).

At one time or another practically every state in the nation has published some type of listing of safety precautions or recommendations to follow when working with toxic pesticides, and the usual statements are common knowledge to most of those who have worked with pesticides for any length of time. Becuase of this, there will be no attempt to enumerate all of these in this discussion. This presentation will cover some of the more important safety precautions related to worker exposure and, in addition, will touch on some of the research related to exposure and safety carried out at the Environmental Protection Agency, Field Studies Section laboratory during the last several years.

There are several important ways to insure safety of the worker such as providing them with education and medical supervision, stressing the importance of personal hygiene and cleanliness, emphasizing the importance of not developing careless work habits, impressing them with the necessity for reading and following recommendations and directions on the pesticide label, and making sure they are provided with proper protective gear and that they understand the importance of their use and care.

Education of Workers

It is essential that all workers who have intimate contact with pesticides have at least some knowledge of pesticides. Well-informed personnel are more likely to be more careful when handling toxic materials and thus help to maintain a good pesticide safety record. Workers should be informed about the different classes of pesticides, i.e., chlorinated hydrocarbon, organophosphorus, carbamate, etc. and their relative toxicity or hazard. Education is one of the most important factors in pesticide safety.

Medical Supervision

Regardless of the size of an operation, it is wise to arrange some type of medical supervision. This is particularly important if exposure is to highly toxic chemicals. A pre-employment physical examination should include a blood cholinesterase test for employees who may work with the more toxic cholinesterase-inhibiting compounds. The test will provide some indication of the normal cholinesterase activity level and may be useful later in determining whether an illness is due to pesticide poisoning. Personnel working with such compounds, especially the highly toxic organophosphorus pesticides,

should have their cholinesterase acitvity checked at regular intervals in order to detect any appreciable deviation from normal which may indicate impending danger of poisoning. If significant reduction in cholinesterase activity is noted, the employee should be removed from the work situation, which might be a source of exposure to pesticides, until the worker is advised by a physician that it is safe to resume his regular duties.

Personal Hygiene and Cleanliness

Even though the employer may provide a relatively safe working environment, the worker should make an effort to protect himself from excess absorption of pesticides through good personal hygiene practices. Applicators should change and launder clothing daily. Workers in a formulating plant should remove street clothing and put on clean work clothing before starting work. Street clothing should not be worn under work clothing. At the end of the work shift work clothing should be removed and placed in a bin to be laundered. This should be followed by bathing in a shower, using plenty of soap to thoroughly cleanse any pesticide from the skin before dressing in street clothing to go home.

If any worker, whether it be in the field or formulating plant, should become excessively contaminated at any time with either dry or liquid concentrate pesticide, he should immediately stop work, bathe and change into clean work clothing before resuming his duties. This is especially important if he has been working with the more toxic organophosphorus compounds. In such case he should be observed for poisoning symptoms.

Waterproof protective clothing should be cleaned daily. It is especially important that such protective gear be kept thoroughly

clean on the inside as well as on the outside.

Workers should never smoke, chew tobacco or gum, drink or eat while working with pesticides. These activities should take place away from the pesticide exposure area. The hands and face should be washed prior to such activities.

Avoid Careless Work Habits

Risk of injury or illness can be minimized by using the best informed and most careful employees in work situations that are potentially the most hazardous. Unfortunately, this principle is not always observed. For example, in many pesticide formulating plants the more hazardous jobs are usually dirtier, require more physical effort and thus are less desirable than other jobs. As a consequence, new inexperienced personnel are often given the more hazardous duties, while those with more seniority and knowledge of pesticide safety move to the more desirable positions. Careless workers are not particularly difficult to detect. Close observations of workers quickly reveal any tendency toward carelessness. Careless workers can jeopardize the health of other workers as well as themselves. They may also produce more contamination of the environment through careless application.

Follow Directions on the Pesticide Label

Information on the pesticide label represents the results of much research and legislation in the interest of safety to the user and the general public. However, it is the individual user who must take personal responsibility to read the label and follow the directions. If all directions are followed explicitly there should be minimum hazard. Anyone working with pesticides should be aware

that the presence of a red skull and crossbones indicates a highly toxic compound. In applying pesticides to food plants and crops, care should be taken to make sure the proper dosage recommended on the label is being followed.

Use of Proper Protective Gear

Direct protection of the routes of entry of chemical compounds into the body as a means of preventing exposure is very important. The routes of entry are dermal, respiratory and oral. Protection is afforded by the use of various items of protective gear, such as special protective clothing, respirators, goggles, etc.

Dermal route: The dermal route is probably the most important route of entry during the most exposure situations especially in the field where liquid sprays are involved. The insidiousness of absorption by that route adds to its hazard. Most persons are aware of the danger of swallowing or breathing pesticides, but the possibility of absorbing appreciable amounts of a poison chemical through the intact skin is not so familiar.

Although cloth overalls or trousers provide a reasonable amount of dermal protection where pesticide does not easily penetrate clothing, the wearing of waterproof trousers provides the best protection for the lower trunk and leg areas and is especially recommended in work situations where there is chance of liquid spillage, soaking by continued contact with more dilute liquid sprays, or penetration of clothing through excessive contact with dry pesticides. Even though regular clothing is covered by waterproof protective gear, it is important that the workers change to freshly laundered clothing each day in order to prevent contamination of skin areas.

In pesticide formulating plants it is especially important to use proper protective gear because exposure is often to the more concentrated forms of pesticides for prolonged periods of time. The waterproof apron is especially needed by the worker at the bagging or mixing stations, as there is often considerable contamination of the front of the clothing from the belt downward. It is very important that concentrate pesticide does not penetrate the clothing to the scrotum because that area has been shown to be the area of greatest absorption on man (7). Protection of the upper trunk and arms from contamination by toxic pesticides is important, especially under field conditions where heavy spray drift may thoroughly wet cloth shirts, coveralls, and underclothing or where concentrated pesticides come in contact with clothing and skin. Our studies have shown that the greatest potential contamination of spraymen in this general body area is the upper back, shoulders, and forearms of workers operating equipment which propels spray up into the air where it is more subject to drift. Under these conditions a waterproof jacket or raincoat provides the best protection for this general body area. This gear is usually worn during cooler conditions, but as the temperature rises and the clothing becomes unbearably hot to wear, workers tend to discard them and work with much less protection--perhaps only a short-sleeved-T-shirt-type undershirt on the upper trunk area. Under such conditions workers should be encouraged to at least wear a long-sleeved cloth jacket that will not be easily penetrated by pesticide, and preferably one that can be properly washed.

The wearing of long-sleeved, closely woven cotton shirts or coveralls as outer clothing during hot weather, often with no underclothing, has been popular with many applicators even though this is not a recommended practice. Fortunately, these items of outer clothing provide a reasonable amount of protection where spray drift is light with very fine droplets that do not wet through to the skin. Under such conditions the clothing should be changed and laundered daily. If clothing used during spraying such as shirts, jackets, or coveralls are merely hung up to dry after work and used repeatedly, as is often the practice, it doesn't take long for the pesticide material to work through where it will make contact with underclothes or skin.

In selecting protective clothing for workers it is important to take into consideration the comfort of the individual when he wears such items. The conventional black or dark green rubberized or plastic waterproof jackets in common use during past years are considered by many applicators to be uncomfortable to wear not only because of greater heat absorption but also because they may be of heavy grade material and not very flexible. During recent years, however, several jackets and jacket-trouser combinations that are lighter in color and weight have been available. Although less durable, they are less costly to replace. Nevertheless, there is still considerable discomfort in wearing any waterproof clothing during hot weather because of trapping of body heat.

Observations of pesticide applicators have indicated that although waterproof clothing items, and especially jackets, are usually carried

by the worker, or readily available to him, he usually will not wear the clothing until exposure to pesticide increases to the point where he feels protection is necessary. Unfortunately, by this time there is often considerable contamination of skin and clothing. The covering of contaminated skin areas by waterproof clothing may create conditions under which dermal absorption may be increased. This may be more important during hot weather where high temperatures and perspiration are involved. Whether or not there would be less absorption under these conditions than if the clothing were left off entirely, depends upon the potential exposure which might occur after the worker puts on the clothing. Although the increase of absorption of pesticide by covering contaminated skin with various items of protective clothing is not known, it is important to emphasize the need to put on protective gear before the skin has been contaminated to any great degree.

Where protection from downward drift is a factor during application of liquid sprays it is important to wear headgear that provided maximum protection to the entire head-face-neck area. The headgear most commonly used by pesticide applicators is the billed cap which provides some protection for the face but very little for the remainder of the head-neck area other than the scalp. The conventional "Sou'wester" rain hat, often used when heavy downward drift occurs, does not provide exceptionally good protection for the face and sides of the neck. This is because of the narrow brim in all areas except at the back of the neck. Metal or fiber "hard hats: are also used to some extent; however, most have too narrow a brim to provide adequate protection.

"Hard hats" which allow circulation of air over the head under the hat should not be used where exposure is to toxic dusts. Our studies have shown that the greatest protection from downward drift of pesticides is afforded by some type of wide-brimmed hat, preferably made of water-repellent material.

Of particular interest in relation to exposure of the head-neck area if the finding by Maibach et al. (7) that absorption of parathion is relatively efficient (47% of applied dose) in the ear canal. Exposure in this area could occur through drift of fine pesticide mists or dusts or by digging the the ear with the tip of a contaminated finger.

It is of importance to note that wearing goggles and respirators provides considerable protection to the face.

Although a statement suggesting the use of goggles can be found on certain pesticide labels, they are rarely worn except by pilots who apply pesticides by aircraft. Questioning of pilots has revealed that they wear goggles not only to prevent poisoning and to keep wind out of the eyes but also to prevent certain organophosphorus pesticides that are direct inhibitors of cholinesterase from causing miosis. This is understandable because it has been shown that unilateral contamination of the eye with TEPP may cause pilots to inadequately judge distance (9). The incoordination which may accompany this could be a serious threat to safety.

The hands are often the body area having the highest exposure to pesticides and they have a greater chance of coming in contact with the more concentrate formulations. They are also more subject to cuts or abrasions, which allows a more direct route of entry through.

the skin. High potential exposure to the hands brings attention to the need for wearing gloves. Some people who have worked with pesticides feel it is better not to wear gloves than to wear gloves that are contaminated on the inside; something which invariably occurs to some degree. Our research concerning the use of protective gloves indicates that, unless there is gross contamination of the inside of the gloves, the potential exposure is less when wearing gloves than when not wearing them. If gloves are kept clean on the inside there is very little doubt concerning the value of their use when handling pesticides. Unlined rubber gauntlet gloves provide the best protection because the gauntlet covers the wrist area not normally covered by the jacket sleeve and they can be turned wrong side out for proper cleansing of the unlined inside surface.

In order to provide proper protection to the feet, waterproof shoes or boots should be worn when handling or applying pesticides on a large scale. When leather shoes become wet with spray material they have a tendency to become cracked and dried out to the extent that pesticide easily penetrates through to the sock or foot. Both leather and canvas shoes absorb chemicals and may hold them in contact with the wearer. Boots should be washed and dried thoroughly, inside and out, as frequently as needed to remove any pesticide contaminant. Rubberized boots are essential in formulation plants. The legs of coveralls should be worn outside the boot tops to prevent dry pesticide from sifting into the footwear.

Respiratory route: Where toxic dusts and vapors or very small spray droplets are prevalent, or where application is in confined spaces, protection of the respiratory route is especially important.

Extremely fine particles and droplets found in dusts and mists are much more easily drawn into the respiratory system than the larger droplets formed by most conventional dilute spray machines. Our tests have shown that when operating an 8X (eight times the normal dilute concentration) concentrate airblast machine in fruit orchards the potential respiratory exposure is nearly 3 times greater than when operating the conventional dilute machine (11).

The cartridge-type respirator provides adequate respiratory protection in most types of application situations. In certain cases it is advisable to use gas masks with special canisters because of their greater adsorbent capacity. Applicator pilots who risk the possibility of flying through drift of fine droplets or dusts should use a face mask equipped with a filter canister attached either to their belt or to the inside of the cockpit. When fumigating or applying highly toxic pesticides in confined spaces it is advisable to use a respirator with a special compressed air supply tank so that none of the contaminated ambient air is inhaled.

If respirators are to be effective they must have proper care. The rubber face-piece becomes hardened and the head straps lose their elasticity with age and exposure to heat and sunlight. These conditions lead to poor fit and allow leakage around the face-piece. Two of the more common offenses in the care of respirators that we have observed are (1) failing to occasionally wash the face-piece with soap and water and (2) neglecting to change the filter cartridges or canisters regularly. Washing of the face-piece of a cartridge-type respirator should not be attempted while the cartridges are in place

as moisture may contact the activated charcoal filter material and reduce its effectiveness in adsorption and absorption of pesticides. Solvents should not be used as a cleaner for they may damage certain parts of the respirator. The general recommendation is that cartridges should be changed after 8 hours of continuous exposure. In most application situations this leaves much up to the individual worker to keep a record of his respirator exposure time. In a formulating plant where hours of exposure are more regular this is more easily controlled under the guidance of a foreman. Under conditions of intense exposure the useful life of the cartridge is much shorter. Thus, if the breathing seems hampered, or if the odor of pesticide is detected, the filter cartridges should be changed immediately. If the outer filter pads are separate removable units they should be changed more frequently than the cartridges.

During disucssions of the respiratory route of entry into the body the question is often raised concerning the hazard of smoking pesticide-contaminated cigarettes. We have found it difficult to measure such potential exposure with any great degree of accuracy. The technique we have utilized thus far involves subjecting the cigarettes to normal handling through the process of removing them from the pack and placing them in the mouth, lighting them, and smoking one-half of the cigarette. The remainder of the cigarette is then analyzed for pesticide content. The values obtained are based on the assumption that pesticide on the cigarette will be volatilized before being broken down by burning and that none of the volatile or particulate pesticide would be trapped in the butt end of the cigarette.

In observing smoking by workers it was noted that the area of greatest contamination of the cigarette was far enough from the butt end to allow burning of the contaminated area in most cases.

In studies of cigarette contamination by spraymen applying endrin in orchards, the potential exposure through smoking during application operations was calculated to be not more than 2 µg per cigarette, even when the cigarettes were handled with hands wet with the dilute spray (16). In later studies (13) involving spraymen applying parathion to apple orchards by airblast machines, up to 18.1 µg of parathion per cigarette could be recovered where they were handled with hands contaminated with dilute spray. Contamination with hands that had contacted the concentrate formulation resulted in values up to 235 µg per cigarette

Even though values for potential respiratory exposure through smoking contaminated cigarettes may not appear to reflect any great hazard, two important points must be kept in mind: (1) Pesticide entering by the respiratory route is practically 100% absorbed, and (2) There is no assurance that a more toxic breakdown product will not be formed and inhaled as the high temperature of a burning cigarette reaches the contaminated areas rather than complete destruction of the compound by burning. For example, in the case of parathion the oxidation product, paraoxon, is estimated to be much more toxic than the parent compound. This could be an important factor as far as hazard is concerned and emphasizes the need for recommending washing of hands and face before smoking.

Oral route: Oral exposure is difficult to measure. We are studying techniques at the present time. Analysis of saliva samples

of exposed individuals appears to give some indication of contamination. Splashing of liquid concentrate into the mouth while pouring and measuring pesticides may produce the most serious oral exposure. Contamination may also occur through licking the lips, by rubbing the mouth with contaminated arms or hands, by careless actions such as attempting to blow out clogged spray nozzles with the mouth, or by eating or drinking with contaminated hands.

We have attempted to measure the parathion contamination of typical sack lunch items, such as sandwiches, cookies, and pickles by workers whose hands had been contaminated while thinning fruit in recently sprayed apple orchards.[1] A lunch consisting of four half-sandwiches, two cookies, and one pickle was given to workers who handled and ate one-half of each item with unwashed hands. The other half of each item was analyzed for parathion. This provided potential oral exposure values for lunch items. A total of approximately 103 µg of parathion was found on the typical lunch mentioned above. Although this is not a great amount of pesticide, it would add to the total exposure of each individual; thus, workers should wash hands and face before eating.

Exposure in Different Work Activities

Degree of exposure in different work activities can be estimated by both indirect and direct methods of measurement. An example of an indirect method of measurement that correlates quite well with clinical effects is the determination of cholinesterase activity in the blood of workers exposed to organophosphorus compounds. Determination of urinary metabolites excreted following exposure to certain pesticides is another example of indirect measurement of exposure.

These methods are used in estimating how much pesticide has actually been absorbed by the body. We have used levels of parathion and DDT metabolites excreted in urine as an indicator of exposure of spraymen applying the pesticides (15). Excretory levels of the metabolites correlated well with direct exposure measurements. Excretion curves for both metabolites showed diurnal variation during the period after exposure had ended. On the average for a specific exposure, more parathion-derived material than DDT-derived material was recovered in the urine.

Direct methods for measurement are utilized to attempt to estimate the amount of dermal or respiratory exposure to which the body is potentially subjected (6). Potential dermal contamination can be measured by swabbing skin areas or by attaching special absorbent pads to different parts of the body or clothing of workers. Contamination of the hands can be measured by rinsing them with a suitable solvent into a polyethylene bag. The amount of pesticide found on the dermal pads, swabs, or bag rinses will indicate the amount of pesticide that may have accumulated on exposed skin areas during a specific period of work activity. Respiratory exposure can be estimated from the contamination of special filter pads held in special single- or double-unit respirators, from air concentration values determined by use of impinger-type air samplers, or both. Chemical analysis of respirator pads or of air samples taken near the breathing zone of workers yields values that can be used to calculate the potential respiratory exposure.

The results of direct measuremetns of exposure to pesticides may be used in evaluating the relative hazards of different routes of exposure, different operational procedures, and different protective

devices. Results of our potential dermal and respiratory exposure studies (4,10,12,14,16,17,19) for several different work situations and compounds are shown in Table 1. These calculated values are based on the assumption that the workers were wearing short-sleeved shirts, no gloves or hats, with clothing worn giving protection of the body areas covered. An important point illustrated by the Table is that the potential for dermal exposure is generally greater than that for respiratory exposure and sometimes it is very much greater. In earlier work at this laboratory (17) we found that potential respiratory exposure to a number of pesticides ranged from 0.02% to 5.8%, with a mean of only 0.75%, of the total dermal plus respiratory exposure. Thus, we feel that dermal exposure is more important than respiratory exposure in many work situations, and especially during application of liquid sprays in the field. It should be understood that any given amount of pesticide is more rapidly and more completely abosrbed by the oral or respiratory routes; however, absorption of pesticides by these two routes is probably too small a fraction of the total potential exposure to be considered the main factor in most poisoning cases of workers in the field.

In one set of experiments, for example, we have calculated the potential dermal exposure of orchard spraymen to parathion to be 17.2 mg/hr; however, the potential respiratory exposure was calculated to be only 0.02 mg/hr of exposure. This indicates that there is potentially over 800 times more dermal exposure than respiratory exposure to workers in that type of application operation. Thus, if only a small fraction of the potential dermal exposure was to be completely absorbed it would probably still be more than the respiratory exposure.

Table 1 also shows that the total percent of toxic dose potentially received per hour of work, assuming all the pesticide was absorbed, is very low for most exposure situations listed. The higher values obtained were for workers more heavily exposed to the more toxic organophosphorus compounds or where extremely high potential dermal and respiratory values were obtained for indoor house spraying with DDT. The flagger for parathion crop dusting by air received the most toxic dosage per hour of work. This was because the worker made no effort to move away from the drift of the toxic dust. The high value is consistent with our observations that air dust application flaggers and loaders are often subjected to greater exposure than most workers in field application situations.

Improvements in quality and acceptability of gear for use in protecting the routes of exposure are needed to bring about better protection of workers. People who work with toxic chemical compounds must realize that even when using the best equipment there is some element of risk involved. Accidents occur, even among workers who are careful. In case of accidental gross contamination of skin with a highly toxic compound every effort must be made to cleanse the contaminated area as thoroughly as possible. At our present state of knowledge about dermal absorption we feel that the use of plenty of soap and water is the best suggestion for removing skin contamination. This must be done soon after contamination because absorption of certain pesticides is relatively rapid. Wash by rubbing with the hands or with a piece of cloth. Do not scrub too vigorously or use a brush because this may cause the outer layer of protective cells of the skin to be abraded enough to allow more rapid absorption of any pesticide

Table 1. Potential Dermal and Respiratory Exposure of Workers to Pesticides[a]

Compound	Activity	Exposure		
		Dermal mg/hr	Respiratory mg/hr	Total % toxic dose/hr
DDT	Spraying apples	54	0.10	0.03
DDT	Indoor house spraying	1,755	7.10	1.02
DDT	Outdoor house spraying	243	0.11	0.14
DDT	Formulating plant	524.5	14.11	0.39
Parathion	Spraying apples	17.3	0.02	1.19
Parathion	Spraying citrus	18.0	0.03	1.17
Parathion	Spraying potatoes	4.7	0.01	0.32
Parathion	Dusting potatoes	7.8	0.16	0.64
Parathion	Thinning apples	8.4	0.06	0.61
Parathion	Flagger--crop dusting	84.0	0.02	5.72
Carbaryl	Spraying apples	59.0	0.09	0.02
Carbaryl	Formulating palnt	73.9	1.10	0.03
Carbophenothion	Spraying orchards	41.3	0.11	1.12
Ethion	Spraying orchards	44.2	0.04	0.26
Endosulfan	Spraying apples	24.7	0.02	0.27
Endrin	Spray orchard cover for mice	2.5	0.01	0.21
Fenthion	Mosquito spray	3.6	0.01	0.02
Fenthion	Hand granular	12.3	0.08	0.06
Perthane	Spraying apples	59.4	0.14	<0.01

[a]Calculated on the basis of the worker wearing a short-sleeved, open-necked shirt, no gloves or hat, with his clothing giving protection of the areas covered.

not removed. A bar of soap, towel, and container of water should be carried on every pesticide application machine or accompanying vehicle for use in washing should a spillage occur. In formulating plants emergency showers and washing facilities should be relatively close to work areas. If pesticide gets in the eyes they should be thoroughly flushed with water for several minutes. If a person should feel ill while working with pesticides he should stop work at once and get medical attention.

In general, our research findings over the last 20 years area consistent with the idea that pesticides can be used safely provided recommended precautions are followed. However, the relatively high exposure values associated with a few of the more toxic pesticides indicate that even minor lapses in adherence to safety precautions might be sufficient to allow poisoning to occur.

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